




**pennsylvania**

DEPARTMENT OF TRANSPORTATION

# Overview of PennDOT's Current Recycled Material Construction Specifications - Webinar



## ➤ Administrative Items

- Handouts
  - Background Noise
  - Sign-in / Course Evaluations
  - Questions
- 

The following information will be provided for each recycled material.

- ❑ General Information
- ❑ Construction Specifications
  - ❑ Gradation Requirements
  - ❑ Quality Requirements
  - ❑ Material Limitations
- ❑ Material source availability, approval, and relative costs

# Reclaimed Portland Cement Concrete (RPCCC) - General Information

- Generated from crushing concrete elements.
- Sources: concrete pavement, construction and demolition debris.
- Can be from mixed sources if supplier demonstrates that materials meet gradation and quality requirements
- Must be free of exposed metal reinforcement or mesh.
- Specific gravities in 2.2 to 2.5 range.

# RPCC – General Information



# RPCCC – General Information

- ▶ Must meet PennDOT's Environmental Due Diligence requirements for Clean Fill.
- ▶ Must comply with all applicable requirements governing clean fill use / placement to be protective of Commonwealth waters:
  - ▶ 25 Pa. Chapter 93 – Water Quality Standards
  - ▶ 25 Pa. Chapter 102 – Erosion and Sediment Control
  - ▶ 25 Pa. Chapter 105 – Dam Safety and Waterway Management



# RPCCC - Construction Specifications

- ▶ RPCCC for Miscellaneous Drainage  
*Special Provision (SP), Item 9613-0001*
- ▶ RPCCC for Rock Lining  
*Special Provision (SP), Item 9626-XXXX*
- ▶ RPCCC for Gabions  
*Special Provision (SP), Item 9850-XXXX*

# RPCCC – Gradation Requirements

- ▶ Miscellaneous Drainage (*Item 9613-0001*): Pub. 408 - Section 613.2, and; Section 703.2 (Coarse Aggregate - AGG), Table B, Type C.
  - ▶ AGG or AGG blends [min. 50% RPCCC] in proportions with conventional AGG to meet gradation requirements, providing all RPCCC AGG or blends are retained on No. 4 sieve.
  - ▶ AASHTO No. 1 and No. 57 gradation requirements.
  - ▶ No fines (minus No. 4) allowed for this application.



# RPCCC – Gradation Requirements

- ← Rock Lining (Item 9626-XXXX): Meets requirements of Pub. 408 - Section 850.2 and;
  - ← AGG or AGG blends [min. 50% RPCCC] in proportions with conventional AGG to meet gradation requirements, with a min. specific gravity of 2.5, determined by AASHTO T85, bulk saturated, surface dry basis.
  - ← RPCCC AGG R-3, R-4, and R-5 rock size classifications.
  - ← If blended with conventional AGG, can meet R-3 through R-8 rock size classifications.

# RPCCC – Gradation Requirements

- ← Gabions (Item 9850-XXXX: Type A and B): Meet requirements of Pub. 408 - Section 626.2 (exclude Section 626(c)1) and;
  - ← Provide AGG or AGG blends [min. 30% RPCCC] with conventional AGG in proportions to meet gradation requirements.
  - ← RPCCC can be produced to meet the Type A and Type B, 3-5 inch and 4-8 inch size requirements.



# RPCC – Quality Requirements

Supplier submits samples to Lab. Testing Section for petrographic examination for durability before use.

► Freeze-thaw testing (ASTM D 5312) with following modifications:

1. Oven dry samples at  $60 \pm 3^{\circ}\text{C}$  ( $140 \pm 5^{\circ}\text{F}$ ).
2. Run 50 freeze-thaw cycles on samples.
3. Largest remaining portion of each sample is passing portion, and remaining smaller portions are failing portions.

Largest allowable loss for any individual sample and average loss for all the samples, **5.0%**

**Gabions / 20.0% Rock Lining and Misc. Drainage**

# RPCCC – Quality Requirements

- ▶ Less than 5 % by mass of foreign materials.
- ▶ High alkalinity can produce leachate with pH values in 5 to 10 range (remnant mortar).
- ▶ Leachate pH diminishes with time, conventional AGG and coarse RPCCC AGG blends, will proportionally diminish pH leachate impacts.
- ▶ Fines (minus No. 4) contribute to higher precipitate levels from leaching of calcium based compounds.
- ▶ All RPCCC AGG are capable of producing various amounts of precipitate.

# RPCCC – Limitations

## **DO NOT USE - for Miscellaneous Drainage:**

- Drainage applications with perforated drainage pipes or where water moving through RPCCC may enter perforated pipe
  - ❑ Unless District directed RPCCC blend, high permeability geotextile, or drain pipes with higher initial drainage permeability alternate design.
- Drainage backfill for aluminum, galvanized steel pipes, or other non-corrosion resistant incidental construction items.
- In direct contact with perennial streams, 300 feet of Exceptional Value (EV) or High Quality (HQ) waters without prior PADEP approval.

# RPCC – Limitations

## **DO NOT USE - for Rock Lining**

- ▶ Applications with direct contact with aluminum or galvanized steel pipes to minimize potential corrosion of pipes from higher pH leachate.
- ▶ In direct contact with perennial streams, 300 feet of Exceptional Value (EV) or high quality (HQ) waters without prior approval from PADEP.

# RPCCC – Limitations

## **DO NOT USE - for Gabions**

- In direct contact with perennial streams, 300 feet of Exceptional Value (EV) or High Quality (HQ) waters without prior approval from PADEP.
- Use corrosion resistant gabions



# RPCC - Advantages

- ▶ Project cost savings realized by reducing concrete transportation and disposal costs.
- ▶ Reduce virgin material quantities and transportation costs.
- ▶ Mobile equipment (i.e., crushers, screens, etc.) is available and can be brought to the project site.



# RPCCC –Source Identification and Approval

- Publication 34 – AGG Producers – Bulletin 14.
- Others sources: must demonstrate that they meet Special Provision quality and gradation requirements.
  - Certified laboratory test data on source material.
  - For AGG produced from controlled source, quality tests performed within the last year.
  - For AGG produced from mixed sources, quality and gradation testing specified by District based on project requirements.

# Tire Derived Aggregate (TDA)



# TDA – General Information

- ▶ Lightweight embankment fill
- ▶ Compacted TDA weighs significantly less than ordinary soils (50 lbs/ft<sup>3</sup> versus 120 lbs/ft<sup>3</sup>)
- ▶ High hydraulic conductivity (1 to 10 cm/s)
- ▶ Low earth pressures
- ▶ Can cost 50% less than conventional lightweight fill materials (expanded shale, geof foam)
- ▶ May eliminate need for staged construction due to reduced overburden pressures



# TDA - Construction Specifications

- ▶ Select Borrow Excavation, Structure Backfill, Tire Derived Aggregate  
*Special Provision (SP) , Item 9203-0100*
- ▶ Production of Tire Derived Aggregate for Embankments and Backfills  
*Special Provision (SP), Item 9703-0100*

# TDA Gradation Requirements

- **Length:** No more than 1% & 10% (by weight); max. dimension > than 18" & 12", respectively.
- **Exposed Metal:** At least 76% and 90% (by weight) of tire shreds with metal fragments encased in rubber that do not protrude > 1" & 2" from edge of tire shreds.
- **Free Steel:** Less than 1% by weight of metal fragments.
- **Deleterious Materials:** oils, gasoline, diesel fuel, hydraulic fluid, grease, ice, snow, burnt tires.

## Gradation:

Sieve Size	8"	3"	1.5"	No. 4
% Passing	75-100%	50% max.	25% max.	1% max.



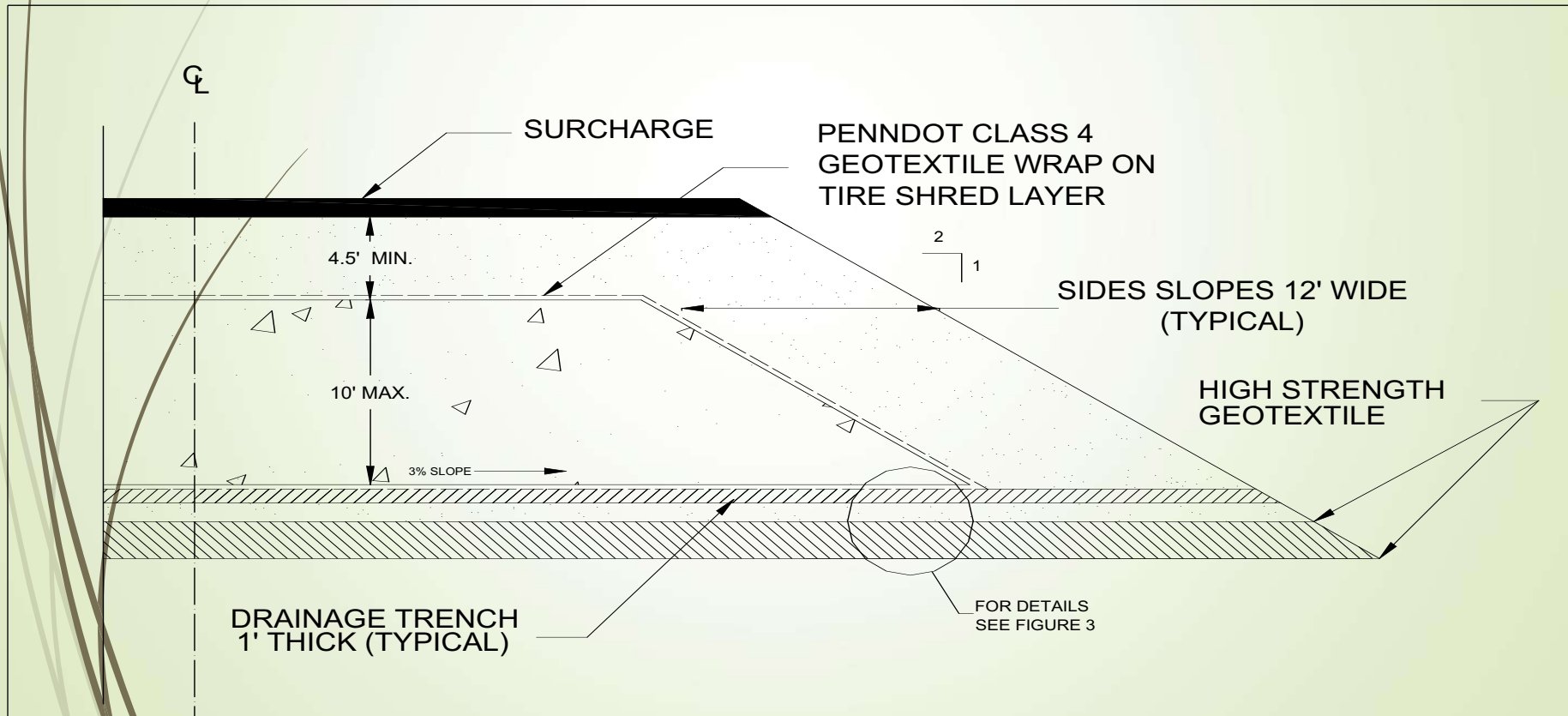
# TDA - Embankment Design Requirements

Item Specification 9203-0100

- Core of TDA, encapsulated on all sides,
- Separation geotextile and soil on all sides, and
- TDA is compressible and requires overbuilding top of each TDA layer.

# Embankment Design Single Shred Layer

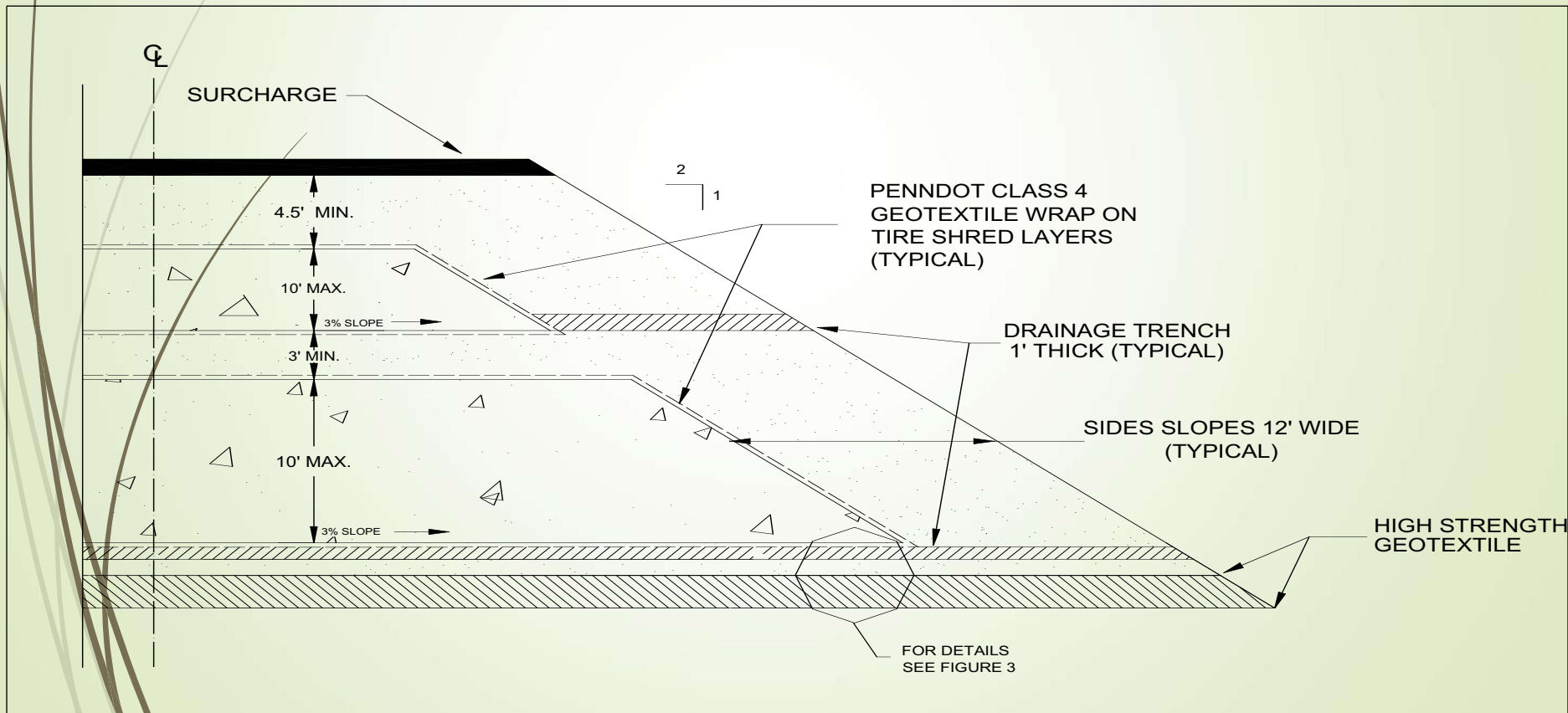
Core of tire shreds encapsulated by soil on all sides with bottom drainage





# Embankment Design Dual Shred Layer

Same as single layer system, but with interlayer of soil





# TDA Embankment Typical Design Values

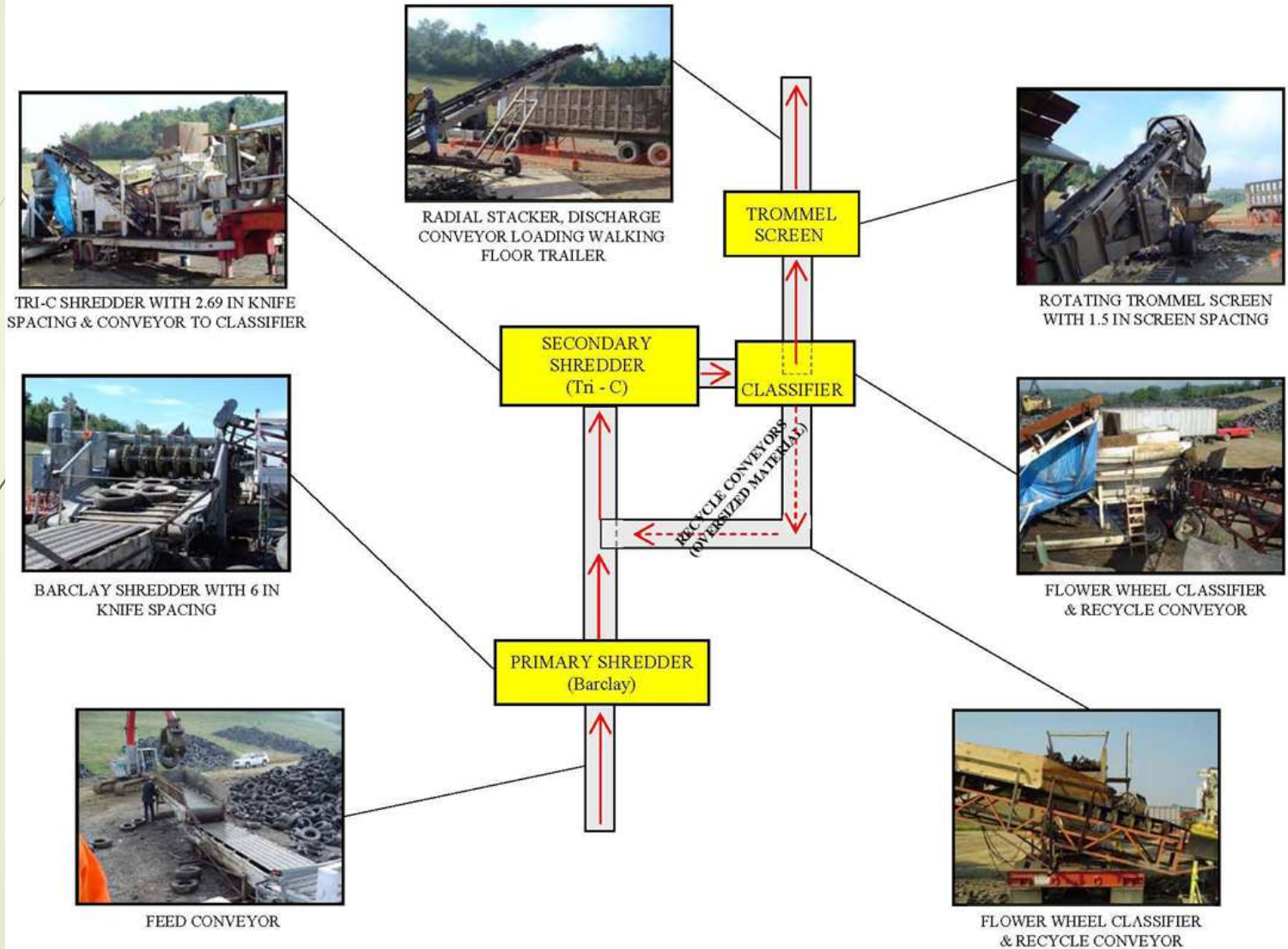
- 100 tires = 1 ton = 1.5 yd<sup>3</sup>.
- Compacted unit weight - 50 lb/ft<sup>3</sup>.
- Compacted dry unit weight – 50 lb/ft<sup>3</sup>.
- Internal angle of friction ( $\phi'$ ) - 27° (toe failure)
- ← Internal angle of friction ( $\phi'$ ) - 25° (deep seated)
- ← Cohesion Intercept ( $c'$ ) - 70 lb/ft<sup>2</sup> (toe failure)
- ← Cohesion Intercept ( $c'$ ) - 0 lb/ft<sup>2</sup> (deep seated)
- ← Active pressure coefficient against abutment ( $K_a$ ) – 0.3

# TDA Production for Embankments and Backfills - Item Specification 9703-0100

PennDOT-approved TDA requires process, not single machine, same way as approved aggregates require crushing, screening, washing, quality control, etc.



# TDA Production – Process Flow Diagram





# TDA-Quality Assurance Testing



Gilson vibratory shaker model (TS-1) with 8", 3", 1.5" sieves and pan.



Clockwise from top left – material retained on 12", 8", and 3" sieve (middle bucket), bottom left 1.5" sieve, and bottom right  $\frac{3}{4}$ " sieve respectively.

# Non-Specification TDA



Length, free, exposed steel



# Approved TDA



Most pieces < 12 inches

Clean cuts most desirable outcome





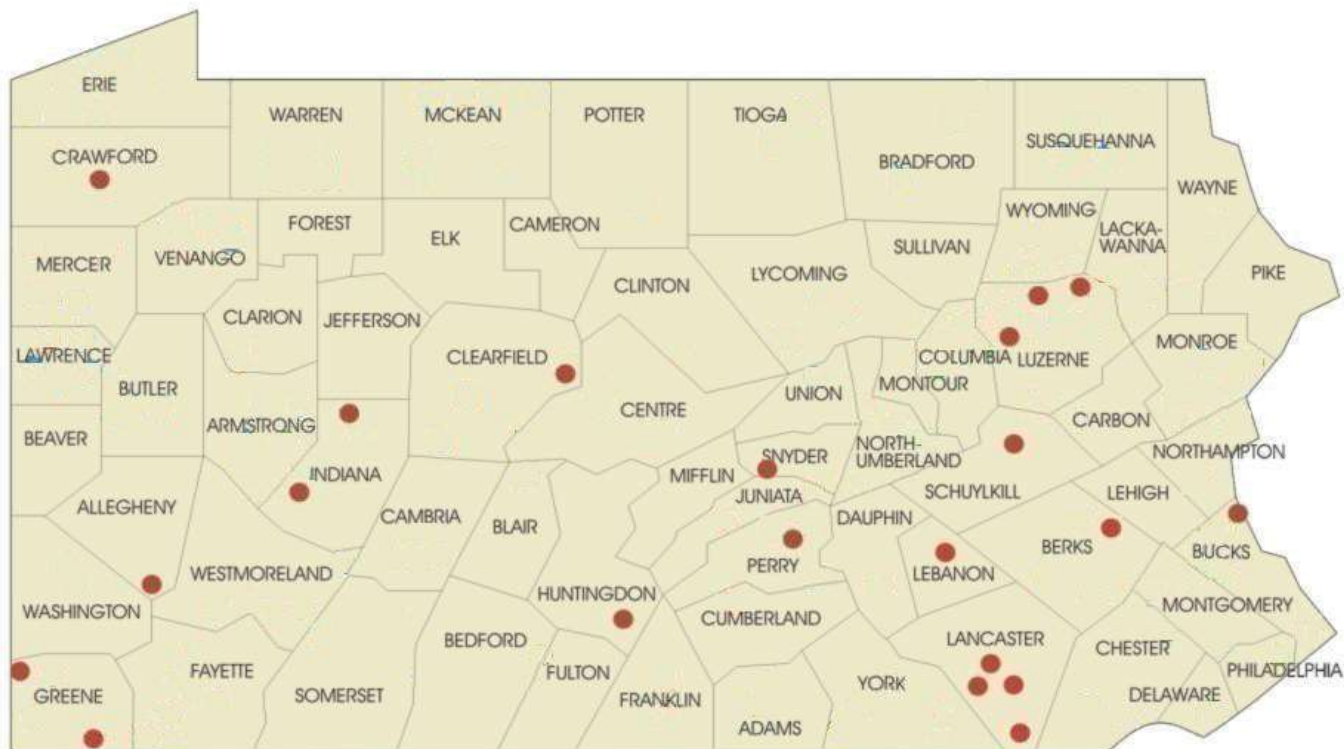
# TDA-Material Availability and Source Identification

- Abandoned waste tire pile cleanups
  - Roughly 925K tires (9,250 tons) in waste tire piles throughout Commonwealth (1/4/2013)
- River sweeps
- Community cleanups

PennDOT SEMP Section and the PADEP can assist in identifying scrap tire sources as recycling of tires will likely involve coordinated effort.




# Pennsylvania Waste Tire Piles



● Remaining Pile







# TDA-Considerations and Limitations

- ▶ For Embankment Construction
  - ▶ Do not place on frozen ground, and
  - ▶ Min. of 2 feet above seasonal high water table and 100 year flood plain level
  - ▶ Placement is critical to avoid foreign material contamination by construction equipment



# TDA-Considerations and Limitations

- For TDA Production
  - Must hold a Beneficial Use Permit, PADEP General Permit No. WMGR038, and
  - Large area required for scrap tire stockpiling and approved TDA staging before placement.

# Crumb Rubber Modifier (CRM) as Stabilizer



# CRM – General Information

- Construction Specification Section 419 – Stone Matrix Asphalt Mixture Design, Restricted Performance Specification (RPS) Construction of Plant-Mixed HMA wearing courses was recently revised to include Crumb Rubber Modifier as Stabilizer.
- Reflected in Publication 408/2011 (change No. 4 / effective April 5, 2013).

# CRM – Construction Specification

- ▶ 419.1 Description—This work is the RPS construction of plant-mixed Stone Matrix Asphalt (SMA), on a prepared surface using a volumetric mixture design developed with the Superpave Gyrotory Compactor.

# CRM – Construction Specification

- Section 419.2(d) – Stabilizer: Provide mineral fiber, cellulose fiber, or crumb rubber (CR) stabilizers conforming to the requirements below and added at a rate specified in Table B. Use the dosage rate prescribed in the job mix formula.
- Crumb Rubber: Use CR derived from processing of recycled tires. Rubber tire buffings from retreading qualify as a source of CR. Furnish processed, free flowing CR from a manufacturer listed in Bulletin 15, certified as specified in Section 106.03(b)3.

# CRM – Gradation Requirements

- **5.a Gradation:** Meet the following gradation as determined according to ASTM D 5461 using 200 mm diameter sieves and maintaining a maximum allowable loss after sieve analysis of 7.65%. As an alternative dry sieve analysis test method, perform sieve analysis of CR according to Florida Test Method, FM 5-559.

**CR Gradation Sieve Size Percent Passing**

4.75 mm (No. 4)	100
2.36 mm (No. 8)	98-100
75 µm (No. 200)	0-3

# CRM – Quality Requirements

- ▶ **5.b Contaminants.** CR must be relatively free from fabric, wire, cord, and other contaminating materials to a maximum total contaminant content of 2.5%
  - ▶ Max. of 1.0% iron
  - ▶ Max. of 1.0% fiber
  - ▶ Max. of 0.5% other contaminants

Determined by weight of total CR sample components.



# CRM – Quality Requirements

- Remove rubber particles from fiber balls before weighing.
- Determine metal content by thoroughly passing a magnet through a 50 + g (1.76 + 0.004 ounces) sample.
- Determine fiber content by weighing fiber balls, which are formed during gradation test procedure.

# Project Opportunities

## Potential Materials

- q Reclaimed Portland Cement Concrete (RPCCC) – Misc. Drainage, Gabions and Rip-rap
- q Tire Derived Aggregate (TDA) - Embankment Material
- q Crumb Rubber – CRM as Stabilizer – HMA Mix
- q Compost – E&S Controls
- q Crushed Glass – Embankment Material
- q Spent Foundry Sand – Aggregate and Flowable Fill



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#### EQAD Pollution Prevention Section

**Our Mission:**

To promote the incorporation of sound environmental practices and the effective application of environmental stewardship principles, into PennDOT's operations by providing technical assistance and quality assurance support in the fields of waste management, pollution prevention, recycling, and environmental management systems.

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# PennDOT's Strategic Recycling Program (SRP) Webpage



# Questions

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